Capturing Uncertainty in the Common Tactical-Environmental Picture

Murray Levine
College of Oceanic & Atmospheric Sciences
Oregon State University
104 Ocean Admin Bldg
Corvallis, OR 97331
Phone: (541) 737-3047 Fax: (541) 737-2064 Email: levine@coas.oregonstate.edu

Award Number: N00014-01-1-0866

LONG-TERM GOALS

The long-term goal of this study is to characterize and represent the uncertainty in describing environmental features that affect acoustic detection by submarines. We will investigate methods on how the uncertainty in our knowledge of the ocean and bottom affects acoustic propagation, acoustic signal processing and, ultimately, the detection, classification and localization of targets.

OBJECTIVES

The primary objective of this component of the project is to quantify the variability of the sound speed field in space and time due to internal waves. This wave-modulated sound speed field is then used by the acousticians to study the effects on acoustic propagation. Assessing the uncertainty in this estimate of internal wave variability will be an essential part of the study.

APPROACH

The approach has been to focus on a particular location, the East China Sea, where there are significant acoustic observations during Sharem 134 that can be used for model comparison. The approach of this component is to generate fields of realistic internal wave variability to be passed on to the acousticians (see Figure). We have assumed the wave field can be adequately represented by a sum of random waves as used in the Garrett-Munk spectrum. The parameterization of the wave field will follow the modifications for shallow water given by Levine (2002). The internal wave fluctuations are sensitive to the background density field, specifically the buoyancy frequency $N(z)$. The resulting sound speed fluctuations also depend on the background sound speed profile $c(z)$ which is primarily a function of temperature in this environment. Part of the problem is to determine the most representative background fields and the associated uncertainty.

The Garrett-Munk formulation does not include some of the most energetic waves that occur in shallow water: internal tide and nonlinear internal wave packets. We are adding these phenomena in a relatively simple way to explore the first-order effects on the acoustic propagation.

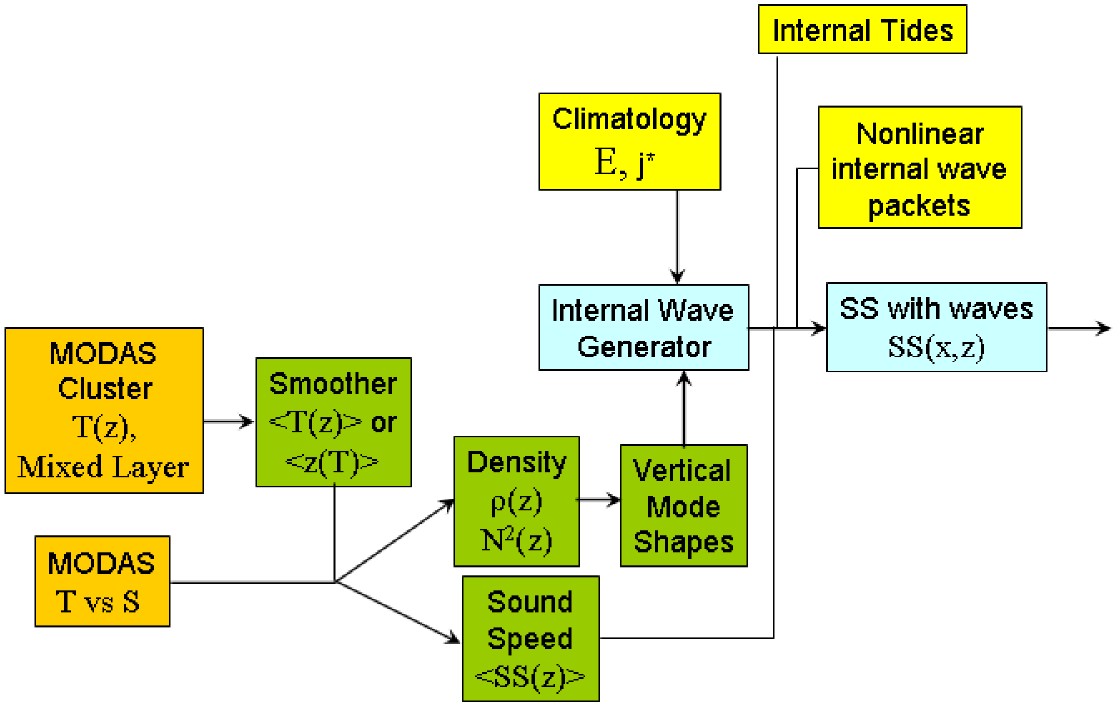
Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2003**	2. REPORT TYPE	3. DATES COVERED **00-00-2003 to 00-00-2003**
4. TITLE AND SUBTITLE **Capturing Uncertainty in the Common Tactical-Environmental Picture**		5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **College of Oceanic & Atmospheric Sciences,,Oregon State University,104 Ocean Admin Bldg,,Corvallis,,OR,97331**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES		
14. ABSTRACT		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**4**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18



The internal wave formulation also needs to be modified to include some additional complicating factors: a non-level bottom and an upper wave number cutoff. These are being implemented by modifying the Garrett-Munk spectrum in a consistent manner.

We will continue to run test cases to explore the effect of the internal wave parameters on the acoustics. The hope is that we can determine the specific features of the internal wave field that most affect the final target assessment. The ultimate goal is to quantify the importance of the internal waves probabilistically.

WORK COMPLETED

The environmental data available were temperature profiles from AXBTs made during the acoustic measurement of Sharem 134. Profiles were also obtained from the MODAS system and from Levitus climatology. We are experimenting with using the MODAS system to produce the most representative profiles using a cluster analysis technique. Even where AXBT data is available appropriate smoothing is needed to estimate the background temperature field. Salinity is also important for the stratification and will most often need to be inferred from an averaged temperature-salinity (TS) relationship.

A number of cases of the internal wave field were given to the acousticians at APL-UW. Their results were subsequently passed on to signal processors at ARL-UT and then to target trackers at Metron. The sensitivity of the acoustics to the internal wave field is being studied and other cases are being constructed to help us learn more about the specific effects and importance on the internal wave field.

An internal wave field that includes a nonlinear wave packet has been constructed using the statistical variability observed on the Mid-Atlantic Bight. Essentially a train of solitary-like waves are added in sequence using statistical descriptions of the number of waves in the packet, the size of each wave, etc.

RESULTS

The impact of the internal wave field on the acoustic propagation and processing has been produced for some simple test cases. The overall the effect of the internal wave field is not large, but is significant at longer ranges.

IMPACT/APPLICATIONS

The goal is to determine how the uncertainty due to the presence of internal waves affects the estimation of uncertainty in target detection. If this proves important, then this study will help indicate the best way to input the internal wave contribution into an overall uncertainty estimate.

TRANSITIONS

The estimate of uncertainty in the internal wave field is a contribution that could potentially be used in a system to estimate overall target uncertainty.

RELATED PROJECTS

This internal wave study is one component of a team effort lead by R. Miyamoto with participants from APL-UW, NRL-SSC, ARL-UT, Metron, and Navoceano.

The PI is involved in ongoing studies of the internal wave field in shallow water funded by ONR through award number N00014-95-1-0534.

REFERENCES

Levine, M.D., A modification of the Garrett-Munk internal wave spectrum, J. Phys. Oceanogr., 32, 3166-3181, 2002.